

Electrical, Electronic, and Magnetic Devices



A successful tool is one that was used to do something undreamed of by its author.

—S.C. Johnson



In the dark of night, a high-rise apartment building burns. Emergency vehicles pull up to it, and the crews need electricity for lamps, power tools, and computers. But in the time it takes to set up and operate a synchronous generator to run the equipment, lives could be lost. Here is a product that could instantly provide emergency crews the power they need.

Blackbird

How It Helps: The Blackbird auxiliary AC power generator supplies 5 kW of instant, under-the-hood power. It provides 120-volt, 60-Hz power at any engine speed, so a user is free to vary engine speed to match the need of other field operations. Idling an engine to save fuel will not affect the power output. Up to 90 percent of the input horsepower is converted directly into useable electric power with no need for a bulky inverter control box. Since a Blackbird connects by belt directly to the main engine, there also is no need for a separate engine, separate generator, or complex hydraulic drive system. The Blackbird is a compact unit (weighing less than 75 pounds) with simple bracket mounting.



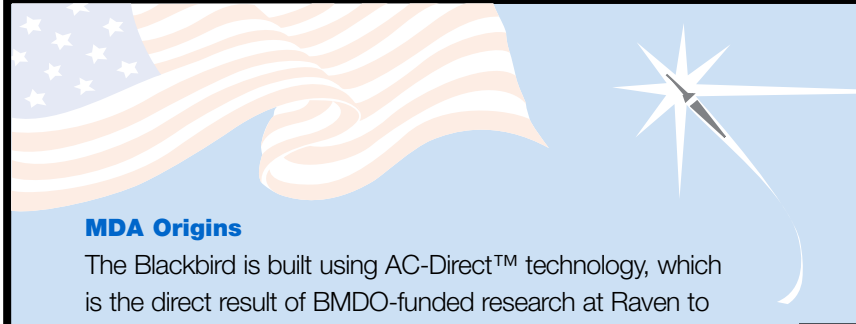
How It Works: The Blackbird power generator is a resonant controller that shapes the output waveform by modulating the level of field coil excitation. As engine speed is varied, the amplitude of the field modulation is adjusted so that the output stays at 120 volts AC. The field control allows a variable-speed engine to produce a constant 60-Hz output with minimal losses. The field control box is easily cooled by natural convection within the engine compartment. To achieve high efficiency, the control system uses two capacitors to capture and store energy for reuse. Net result: up to 5 kW of normal household-type current available instantly from an engine running at any speed.

How Much It Will Cost: Prices vary depending on custom user-specified accessories and installation, with an estimated range of between \$4,000 and \$6,000.

When It Will Be Ready: A series of preproduction units is being readied for beta tests in early 2003, and a commercial unit, aimed at the emergency services market, is scheduled for release in mid-2003.



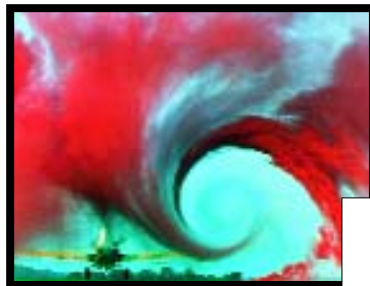
Who Is Working On It: This product was developed by Raven Technology, LLC. Raven was founded in 1998 by Christopher Tupper and Duncan Wood (formerly of Dirigo R&D, Inc., which was founded in 1990 and continues to exist today with Mr. Tupper as its president) and registered as a limited liability company in 1999. It employs eight people and occupies 3,000 square feet of office space in Brunswick, Maine. For more information, contact Christopher Tupper of Raven Technology at (207) 721-1044 or raven@raventechpower.com. The company Web site is www.raventechpower.com.



MDA Origins

The Blackbird is built using AC-Direct™ technology, which is the direct result of BMDO-funded research at Raven to develop a lightweight and fuel-efficient mobile electric power generator. Under a 1997 SBIR Phase I contract, researchers proved the feasibility of a 120-volt, 60-Hz, 2-kW unit using a wave-shaping technique that modifies alternating current. Company engineers extended their efforts in 1999 under a Phase II award and developed prototype and field test units with improved efficiency and higher output.



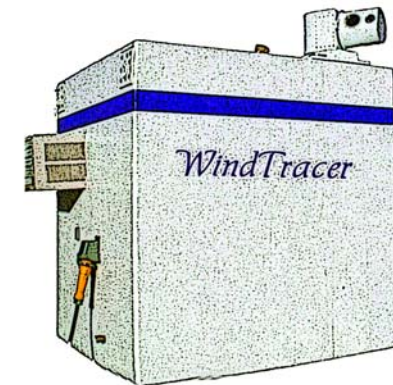


Just as a ship leaves a wake behind it in the sea, an aircraft leaves a wake in the air. The rapidly swirling air in a wake can catch the wings of nearby aircraft, with potentially disastrous results. Because of this danger, air-traffic controllers provide adequate spacing between aircraft—a procedure that ultimately reduces an airport's capacity. Here is a product that could allow aircraft to fly closer together to ease airport congestion.

WindTracer®

How It Helps: The WindTracer Coherent Doppler Lidar system detects dangerous air currents created by large commercial aircraft. It helps pilots avoid dangerous patches of air. Air-traffic controllers can direct traffic more efficiently by knowing immediately when it is safe to send another plane down a runway or allow one to land. By optimizing take-offs and landings, airport capacity and flight safety can be increased. Without technology to monitor wake vortices, pilots and air-traffic controllers must rely on experience and educated guesses to determine how to avoid or cope with wind turbulence near airports. Carried aboard aircraft, WindTracer can let pilots at cruising altitudes know the location of nearby areas of air turbulence, allowing them to find a more favorable cruise altitude that will improve flight safety and fuel efficiency.


How It Works: WindTracer measures wind direction and speed using pulsed laser energy at an eye-safe wavelength (in the range of 1 to 2 microns). The system bounces the energy off dust particles or aerosols in the air. It then records and processes the backscatter from particles in real time. Wind direction is determined by scanning an area multiple times from multiple angles. Wind speed is measured by comparing the Doppler frequency shift of backscattered energy with the frequency of the released laser energy.



How Much It Will Cost: A typical installation of the system at an airport can run from \$750,000 to \$1.2 million.


When It Will Be Ready: The product is ready and in use now. WindTracer has provided forecasters at Hong Kong International Airport with high-resolution images of the windshear and turbulence environment at the airport. The airport is near a large mountainous island that sometimes causes windshear and turbulence. Other wind hazards arise due to sea breezes. The customer for the WindTracer in Hong Kong is the Hong Kong Observatory. The Federal Aviation Administration also is using WindTracer to support its Wake Turbulence Research Program, which is focusing on improving capacity at airports.

Who Is Working On It: The product was developed by CLR Photonics, the commercial products division of Coherent Technologies, Inc. (CTI). CTI develops and manufactures laser radar systems for military and commercial customers. Founded in 1984 by Milton Huffaker, the company currently employs 150 people and occupies a total of 40,000 square feet of leased space in Lafayette and Louisville, Colorado. For more information, contact Paul Reveley of CTI at (303) 604-2000 or paulr@ctilidar.com. The company Web site is www.ctilidar.com.



MDA Origins

From 1989 to 2002, CTI received 12 BMDO and MDA SBIR Phase I awards to develop laser-based technologies for missile tracking, discrimination, and kill assessment. For example, the technologies could be used to discriminate between real and decoy warheads released in the mid-course portion of a ballistic missile's trajectory. One notable research effort sought to improve the range of current lidar tracking systems, which would allow MDA to reduce the total number of sensor-monitoring and missile-interceptor platforms.





A critically ill patient clings to life in a hospital intensive care ward with the help of a respirator. Suddenly, the main power source to the building is cut by construction workers digging in a nearby neighborhood. Panic grips the nurses attending the patient because a short moment without power could disable respirators before the hospital's backup generator turns on. Here is a product that could run sensitive equipment for a short duration until backup power kicks in.

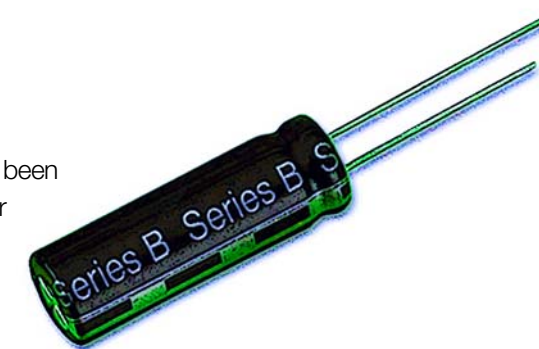
PowerStor®

How It Helps: The PowerStor aerogel capacitor offers big electrical storage capabilities in a small package. The capacitor has extremely fast discharge capabilities and low equivalent series resistance, which make it ideal for pulsed power applications. The device has high energy density (100 times greater than electrolytic capacitors) and high power (10 to 100 times greater than conventional lithium batteries). Because there are no chemical reactions, it can be recharged hundreds of thousands of times without degradation. Other advantages include small size, low cost, and reliable operation over a wide temperature range.




How It Works: The PowerStor aerogel capacitor is based on a novel material called carbon aerogel. Carbon aerogels consist of interconnected nanometer-sized particles with small pores. This monolithic structure leads to very high surface area (the equivalent surface area of 10 football fields) and high electrical conductivity. Capacitors can be made using thin-film carbon aerogel paper as both the positive and negative electrodes. A microporous separator is placed between the two electrodes, creating a sandwich that is wound in "jellyroll" fashion and housed in an aluminum or steel can. The can is then filled with electrolyte and sealed, with protruding leads. When the capacitor is charged, positive and negative ions are oriented along the surfaces of the oppositely charged electrodes. As energy is released, this orientation relaxes back to a disorganized state.


How Much It Will Cost: A full line of aerogel capacitors has been designed for memory backup, pulsed power, and main-power applications. Prices range from \$0.25 to \$30, depending on the type and quantity desired.



When It Will Be Ready: More than 10 million of these devices have been sold in Asia, Europe, and the United States, with new applications emerging monthly. One notable customer, Microsoft, uses the capacitor to power the clock in its new X-Box™ gaming console system. Several aviation equipment manufacturers install the device in their aircraft displays to maintain continuous voltage when switching from one electrical bus to another. Other applications include low-tech toys, valve actuators, and insulin pumps.

Who Is Working On It: Cooper Electronic Technologies is selling these devices. The company acquired this technology by purchasing PowerStor, a subsidiary of the now-defunct PolyStor Corporation. PolyStor licensed the aerogel capacitor technology from Lawrence Livermore National Laboratory (LLNL), which originally developed the technology. PowerStor employs 25 people in its 18,000-square-foot office facility in Dublin, California where the capacitors and their electrodes are made. The business unit also owns manufacturing facilities in Malaysia and China; these plants produce the capacitor's packaging. For more information, contact Marc Juzkow of Cooper Electronic Technologies at (925) 828-6700 or mjuzkow@cooperet.com. The company Web site is www.cooperindustries.com.





MDA Origins

In 1992 and 1993, BMDO funded LLNL to develop the carbon aerogel capacitors for use in lightweight batteries for space applications. The higher energy densities of the capacitors translate into more power stored in a smaller package. Banks of aerogel capacitors could be used to provide energy for electronic subsystems, such as those used for computers and communications.



When you press the power button on your television, it instantly comes to life. But do the same thing with your computer and you are kept waiting while it boots up. Here is a product that could allow a computer to turn on instantly.

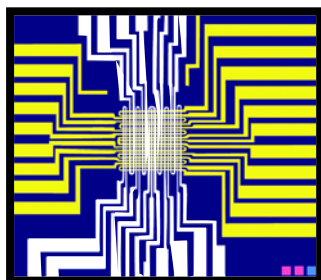


MRAM

How It Helps: Magnetic random access memory (MRAM) has the power to eliminate the boot-up process and enable instant-on computers and systems that consume less power. By combining the high speed of static random access memory (SRAM) and the high density of dynamic random access memory (DRAM), MRAM could be used to significantly improve electronic products by storing greater amounts of data and providing faster access

speeds than existing electronic memory. MRAM devices will be considerably cheaper to manufacture than semiconductor-based DRAM and SRAM technology. MRAM is also expected to substantially reduce the power drain for battery-powered devices because it does not need to be constantly refreshed.

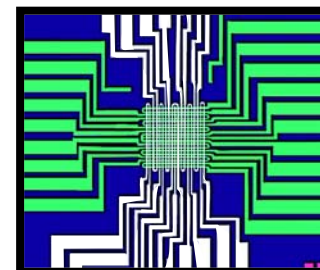
How It Works: MRAM consists of two layers of magnetic material separated by a thin, non-magnetic metallic layer through which electrons may pass. Two parallel conducting lines are laid at the top half of this ferromagnetic sandwich. Another set of conducting lines are laid perpendicular to the first set on the bottom half of the sandwich, resulting in a grid of conducting lines. Each point where the top and bottom lines meet represents a bit. When current is passed simultaneously to the top and bottom lines of the bit, data may be read or written. Once data are written, they remain even when the power is removed. This capability is unlike conventional random access memories, such as DRAM and SRAM, that store information only as long as electricity flows through them.





How Much It Will Cost: The goal is to make MRAM competitive in price with conventional memories like DRAM and SRAM.

When It Will Be Ready: MRAM production for high-end computer systems could begin as soon as mid-2003. The product should be in mass production by 2004.

Who Is Working On It: An innovator in this technology is NVE Corporation, a publicly traded company. Founded in 1989, the electronics component manufacturer now specializes in combining magnetically sensitive materials with integrated circuits. MRAM is the primary focus of the company. Because of the capital investment required for large-scale production of memory, NVE made a strategic decision to license its intellectual property and partner with memory manufacturers. Current licensees include Cypress Semiconductor, Motorola, Honeywell, and Union Semiconductor Technology. NVE currently employs 61 people and occupies 21,000 square feet of office space and development facilities in Eden Prairie, Minnesota. For more information, contact Bob Schneider of NVE at (952) 996-1603 or bobsch@nve.com. The company Web site is www.nve.com.



MDA Origins

Much of NVE's early research in MRAM was funded by BMDO's SBIR program. In 1993, NVE won a BMDO SBIR Phase II contract to design MRAM cells down to 0.05 micron line widths using electron-beam microscopy. In 1997, the company was awarded a BMDO SBIR Phase I contract to integrate giant magnetoresistive materials with semiconductor transistors. In 2002, it was awarded an MDA SBIR Phase I contract for magnetothermal MRAM designed to further increase both MRAM density and temperature tolerance. MRAM devices are ideal for BMDO space systems because they are radiation-hardened when combined with a radiation-hardened memory underlayer and can operate over a wide temperature range.

